ENERGY DEPENDENCY AT THE URBAN SCALE AND ITS SOCIAL CONSEQUENCES

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1. INTRODUCTION

1.1. Relevance of research

According to current Europe 2020 context, the State Members are commited with the development of an inclusive economy with a strong emphasis on job creation on poverty reduction. Align with that objective and within the same strategy, the EU has undertaken to reduce greenhouse gas emissions by at least 20% compared to 1990 levels or by 30% if the conditions are right, increase the share of renewable energy in final energy consumption to 20%, and achieve a 20% increase in energy efficiency. Nevertheless the accomplishment of some of these aims may worse other areas. The implementation of some energy efficiency measures may be not affordable for the whole population, especially for those more in need who are at risk of being left behind.

In addition, peak oil phenomena and fuel raising costs (Campbell & Laherrere, 1998) are also relevant issues to assess, because the way cities work could not be the same without this kind of energy. It is very important to tackle the probable lack of this sort of power source. Nowadays, a large part of the planet's population located in urban and suburban areas is oil dependent, therefore a sudden rise of fuel prices could be a social disaster and, acording to some studies (Sempere & Tello, 2007) and, this rise will take place in a few years because peak oil.

1.2. Aims and objectives of the study

Show the whole picture of social inequalities due to energy dependence.

Identify the energy expenses / needs of the population in each of the land scales

Identify the capacity of the physical support to meet the needs of the population and to address the social inequality problem derived from the energy dependence.

2. SOCIAL EXCLUSION RELATED TO ENERGY USE

2.1. State of the art / Literature review

Physical planning, the roads layout and location of uses and intensities are the big items ending setting the final energy consumption of a territory. In this context, the spatial segregation is one of the causes of the high mobility form life of our society. We not only spend much time on these trips, we also consume a lot of energy in them.

During the last decades, the metropolitan areas have been growing laying in the abundance of fossil fuel energy (Fernández Durán, 2011). The characteristics of those areas are low density suburbs with single use zoning (spatial segregation) and the proliferation of car dependent communities. There are a lot of ecological, environmental, social and economic problems related to the growing of the Metropolitan sprawl.

The lack of mobility could be, by itself, a cause of social exclusion without being linked to other kind of privations. One of the most accepted definition is the following:

> *It is the process by which people are prevented from participating in the economic, political and social life on the community because of reduced accessibility to opportunities, services and social networks,*

due in whole or part to insufficient mobility in a society and environment built around the assumption of high mobility.

(Kenyon et al. 2002).

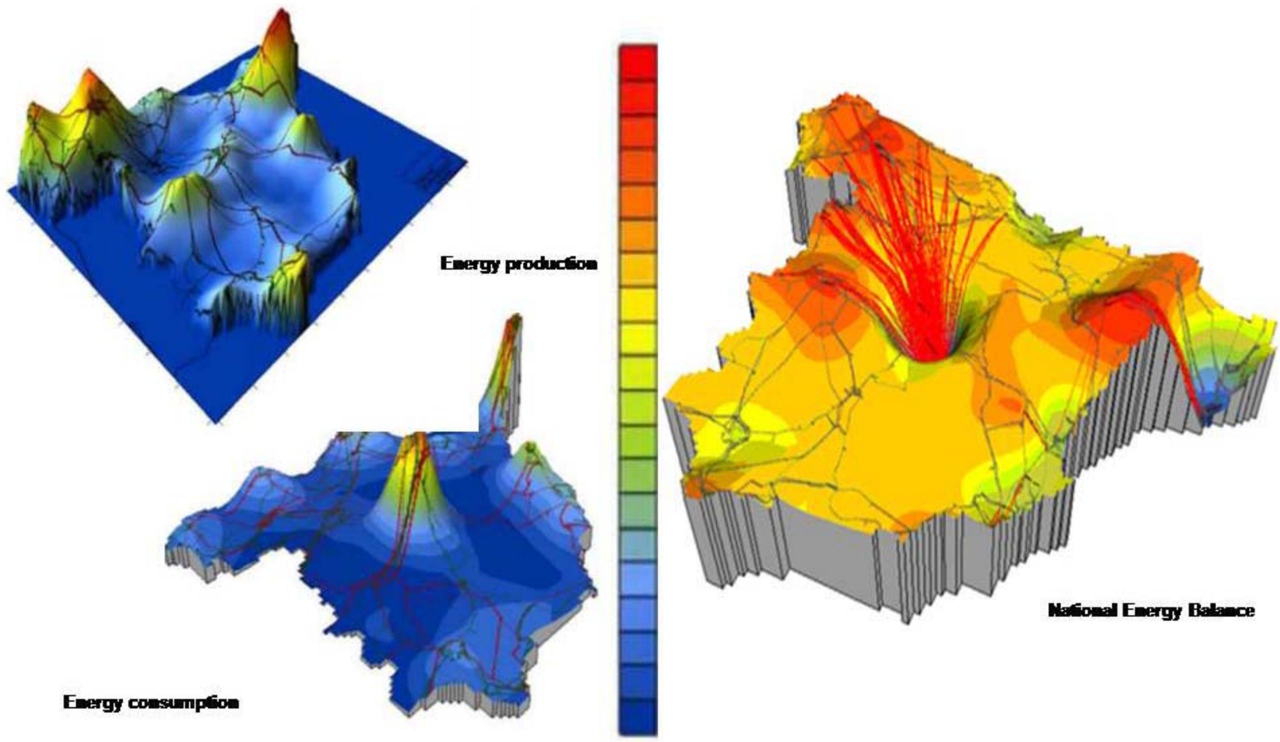


Figure 1. Energy production, energy consumption and national energy balance

The best known form of social exclusion related to energy up to date is fuel poverty which can be defined as the 'inability to afford adequate warmth in the home'. Yet to be officially defined by the EU, UK was the first state member in launching a Fuel Poverty Strategy in 2001 (Boardman, 1991; Warm Homes and Energy Conservation Ac t, 2000) in which a household was considered to be fuel poor if it is unable to have adequate energy services for 10 per cent of income (DECC, 2010).

Since that date some other methodologies have been developed for the rest of Europe based on households reported data in the European Household Living Conditions Survey (Healy and Clinch, 2002)

In Spain, fuel poverty has not been recognized but recent reports show a rate of 15% of Spanish households under fuel poverty threshold (Tirado & Herrero, 2014).

3. MATERIAL AND METHODS

Our intention is to show how it affects the energy dependence in different levels. For that we have structured the document in three distinctive scales: metropolitan, urban and neighborhood. Depending on the scale on which we are working, several indicators will be analyzed. We will always try to explain how each scale energy consumption affects to the socioeconomic indicators.

First of all we analyze mobility of the metropolitan Madrid scale. In this case our work is based on 2001 census data and other available sources. Crossing this data, we analyzed the movement of one municipality to another. Similarly, a cross on indicators associated with mobility required for work based on the income of each of the municipalities of the metropolitan area carried out that year.

Given the importance of mobility-related shopping and leisure, in the fifth chapter we have focused on this aspect. To do this, we have focused only on three very different peripheral towns. Although different from each other, they can be considered as a the representative model in their territorial context. For this we analyzed the Relation between dependence on private vehicle for shopping and leisure, and ratio commercial stores/ housing units in each.

In a third step we referred to the neighborhood scale and dwelling. In this context we have analyzed the exploitation of Spanish Surveys for different levels. We work with the Family Budget Survey data and with the Household Living Conditions Survey data. Both data referring to 2011. To know what happens to the energy dependence in this scale, we also work with the 2001 data census and with the Households and Environment Survey data from 2008.

4. FORCED MOBILITY IN THE METROPOLITAN AREA

4.1. Dependence on fossil fuels for the access to work in Madrid Metropolitan Area

In the metropolitan and urban scales, the energy dependence is associated to transport. Taking this into account, it must be highlighted that the 98% of the energy used for transport comes from oil. Therefore, the transport related vulnerability has a higher risk than others, because it relies on a specific sort of energy, the oil.

The first approach to the issue of energy dependence was done in the metropolitan scale, where a general overview of the forced mobility situation was carried out. It is understood by forced mobility the people’s journeys from their residence to work. Thus, the study was focused in employed population over 16 years old, who use private car transport in their commutes to work. In the metropolitan area map (Figure 2) is shown the very high number of municipalities where the percentage of commuters to work by car is above 40% of the total commuters. Also, a few towns reach almost 70%, such as Cobeña, Daganzo de Arriba or Ajalvir.

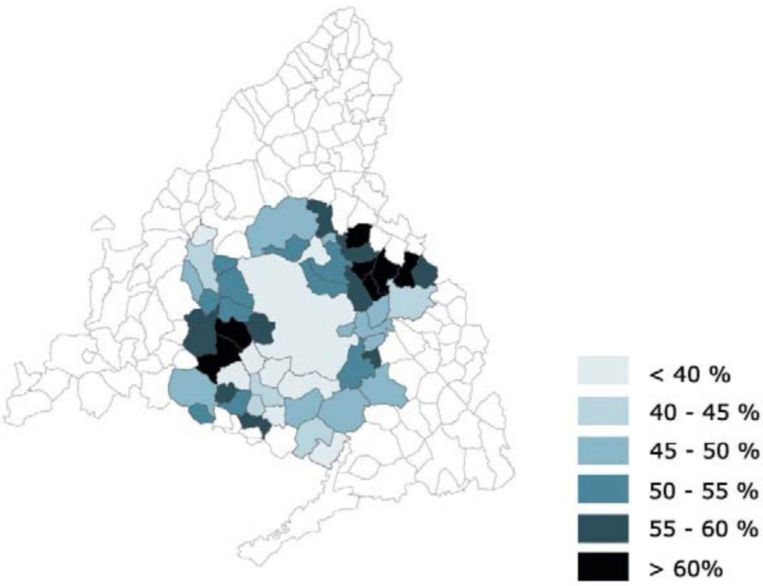


Figure 2. Forced mobility map: percentage of the employed population over 16 years old, who use private car transport in their commutes to work. Self compilation (INE, 2001).

As can be noted from the figure 3, in all the municipalities (except for Madrid and Arganda del Rey), at least half of the car commuters travel daily to another municipality. This is an additional negative factor for their vulnerability situation, because they may not be able to change their mean of transport (into city buses, cycling or walking) due to the long distance. The cases of Arroyomolinos, Boadilla, Cobeña o Velilla de San Antonio are particularly serious, because the percentage is more than 85%.

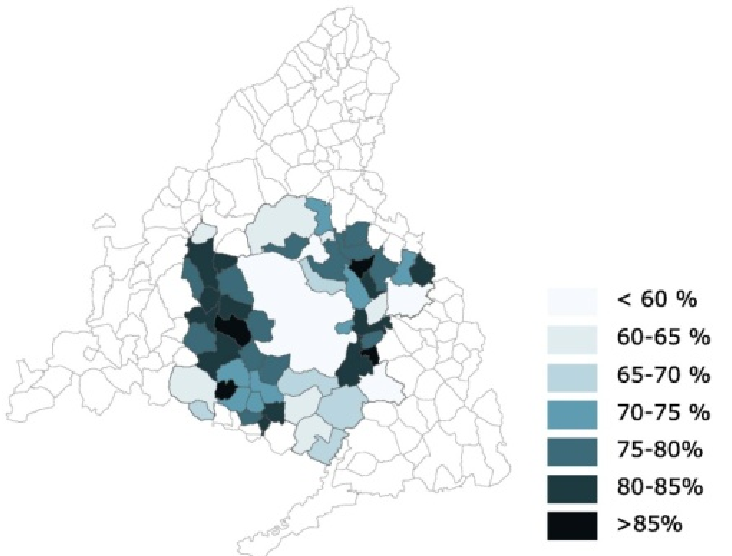


Figure 3. Forced mobility map: percentage of the employed population over 16 years old, who are car commuters and work in other municipality Self compilation (INE, 2001).

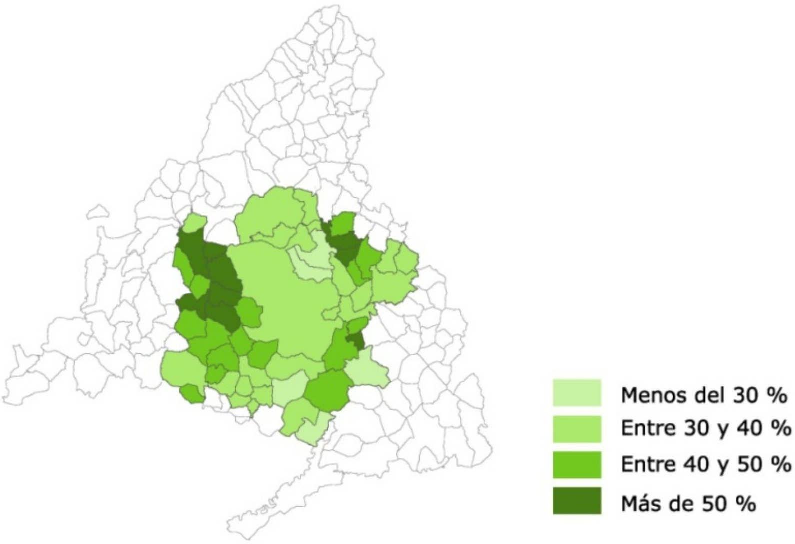


Figura 3. Forced mobility map: percentage of the employed population over 16 years old, who are car commuters and expend more than 30 minutes. Self compilation (INE, 2001)

Another relevant factor analyzed is journey time. Car commuters who spend more than half an hour are more vulnerable because they expend more petrol and if they decided to change their mean of transport the journey trip would take a disproportionate amount of time. At least half of the car commuters from Algete, boadilla, Cobeña, Galapagar, Las Rozas, Torrelodones, Velilla and Villanueva de la Cañada spend more than half an hour.

4.2. Urban and social consequences of metropolitan forced mobility model

A per capita income levels analysis was done, once the pattern of mobility had been studied. This new analysis let us know if a specific municipality or town is above or below the average income level of the Autonomous Region of Madrid. As shown in the figure 4, the majority of the municipalities located in the south and southeast has the lowest income levels in the metropolitan area. This map clearly reflects a historical socio-spatial segregation in this region, where the high income population is usually located in the north and the working class usually lives in the south.

In order to calculate the *energy vulnerability cross-indicator* the following indicators were used:

$$\textit{Energy vulnerability cross-indicator} = \frac{\text{Municipality car commuter level}}{\text{Municipality income level}}$$

The higher this indicator is, the higher is this municipality energy vulnerability. The most affected municipalities are shown in figure 5.

There are a lot of municipalities with high energy vulnerability due to a high car commuter level and a low income level. This vulnerability could be worse in that cases where the journey time is longer than half an hour or the cars commuter travel to another municipality. This will be the case of, for example, Daganzo de Arriba. In addition, this municipality, with just buses (neither train, nor underground, nor night bus service) is a clear energy vulnerability example.

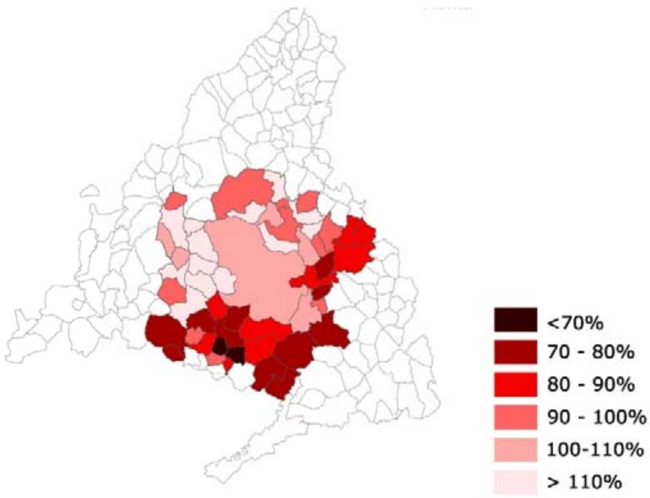


Figure 4. Income level map in relation to the regional average. Self compilation (Instituto de Estadística de la Comunidad de Madrid, 2001).

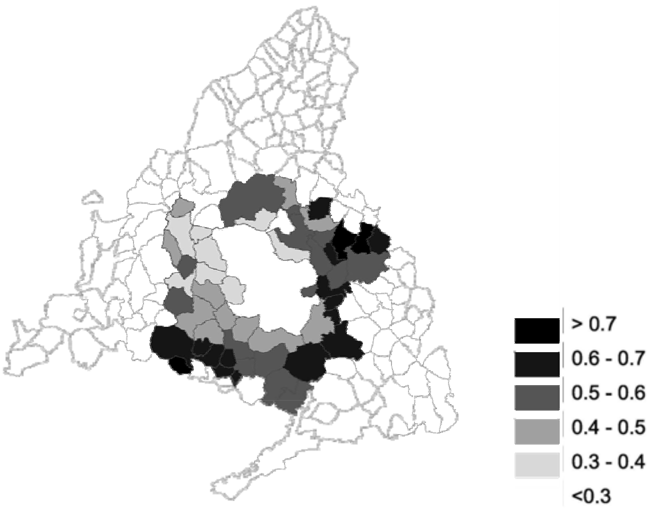


Figure 5. Energy vulnerability cross-indicator map. Self compilation

5. MOBILITY INCITED BY THE METROPOLITAN MODEL: SHOPPING AND LEISURE

5.1. Dependence on fossil fuels for the access to shopping and leisure in Madrid Metropolitan Area

In the previous section, we have analyzed the generation of daily mobility because of the forced mobility. This section deals with the mobility incited by the Metropolitan model for the access to shopping and leisure. This kind of mobility is more related to the different lifestyles and social relations found in the center and in the peripheral towns of Metropolitan Areas.

For this analysis, we have selected three peripheral towns of Madrid Metropolitan Areas: Alcalá de Henares (historical town which had an important industrial development in the 60s and 70s), Getafe (southern town whose urban development was strongly conditioned by the industrial growth since the 60s), and Las Rozas (residential town with sprawl suburbs for higher classes). We have opposed the mobility in these three towns with the one in the central districts of Madrid Municipality.

The Figure 2 shows the relation between the ratio of commercial stores for housing units (axis X), and the dependence on private vehicle (axis Y), for different neighborhoods in the three peripheral towns and in the central districts of Madrid. The first conclusion we can infer is that private vehicle dependence is considerably higher in the metropolitan periphery than in the downtown, proving that the metropolitan spread has been based on the universal access to private vehicle and on the abundance of fossil fuels.

The second conclusion is the relation existing between the urban support (balance between commercial stores and housing) and the dependence on private mobility. We find that the peripheral towns show a more direct and “canonical” relation between these data: The higher the commercial services, the lower the private vehicle dependence. This expectable relation is quite clear in the periphery, in which we find a wider variety of situations: from low commercial ratio and high dependence in Las Rozas, to the opposite case in most of neighborhoods of Alcalá and, specially, Getafe.

However, the neighborhoods in central districts of Madrid perform in a different way. Most of them are placed in the same area of the chart, with medium-high commercial ratio and low car dependence, being the only particular case the commercial hubs in Centro or Salamanca. Madrid downtown presents a more balanced commercial structure, with enough facilities for shopping and leisure in all the neighborhoods. This balanced urban support allows a lower dependence on private vehicle in all the neighborhoods, either with higher or lower incomes. So, in the downtown we do not find the direct relation between commercial services and private vehicle dependence that there was in the periphery.

5.2. Urban and social consequences of metropolitan model for shopping and leisure

Considering the previous results, we can conclude that the urban structure of the traditional downtown allows a lower dependence on the private vehicle for the access to shopping and leisure and, consequently, lower energy consumption. On the other side, the peripheral towns are related to a model of mobility with a high dependence on private vehicle, even for these not-working activities.

The chart reflects also the existence of a simplified and polarized model for access to shopping and leisure in the periphery, in contrast with the balanced one in the downtown. The difference between the two metropolitan spaces is the urban support: The neighborhoods in peripheral towns have been developed according to a commercial model based in malls, with low presence of local stores and huge differences between the different areas. In this model with large distances between the different uses, the access to energy and fossil fuels is the parameter which determines the accessibility (or not) to the different services. Consequently, in a future oil shortage scenario, the population with lower incomes would be the one who could not access to these primary services.

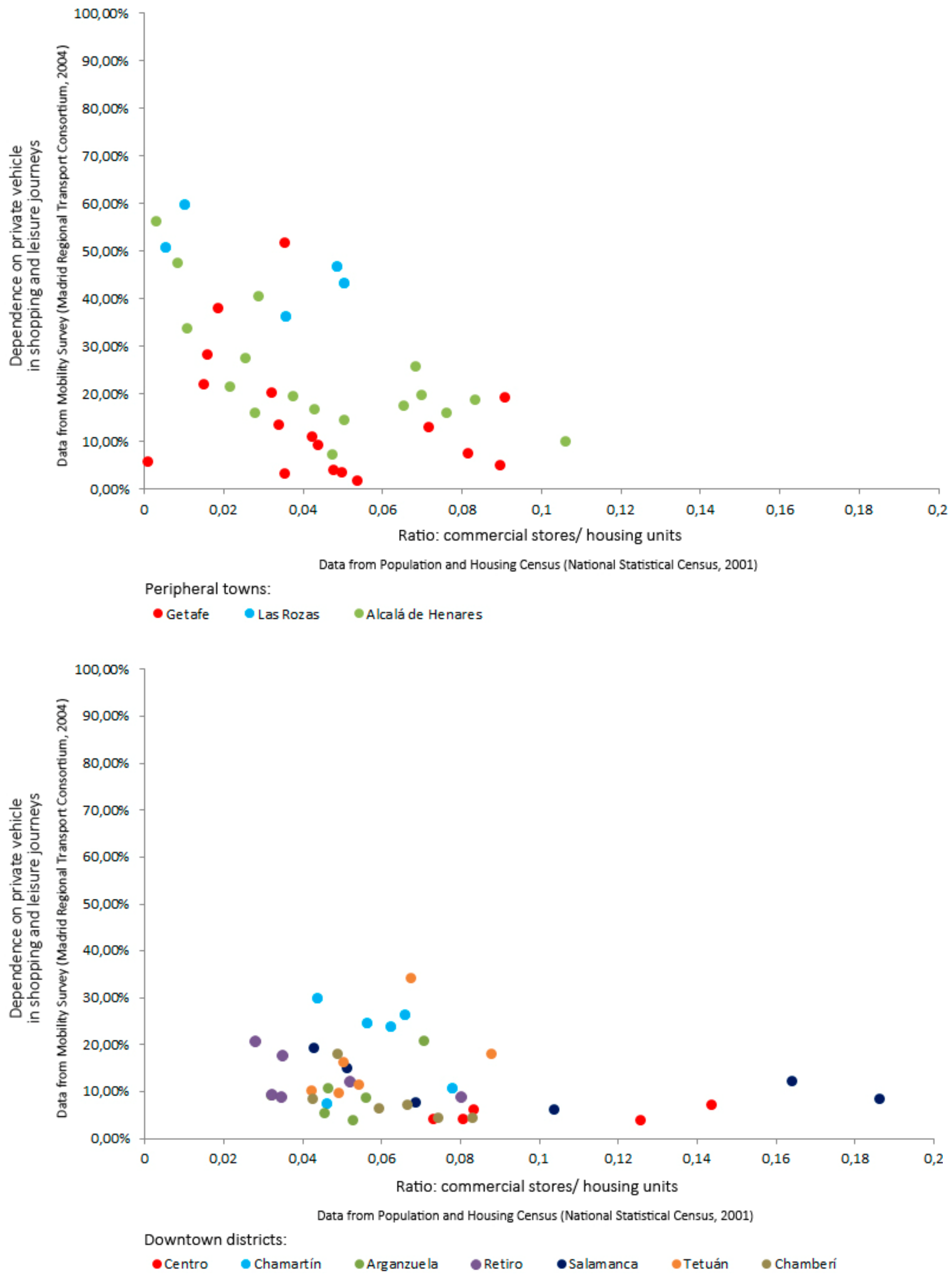


Figure 2. Relation between dependence on private vehicle for shopping and leisure, and ratio commercial stores/ housing units. Self compilation

6. NEIGHBOURHOOD AND DWELLING SCALE. HOUSEHOLDS ENERGY CONSUMPTION

6.1. Residential sector energy dependency

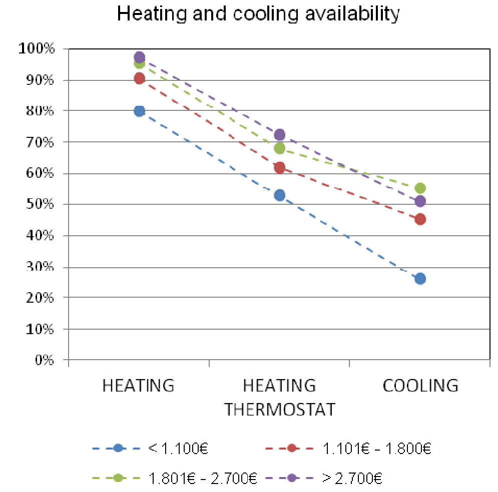
The strong energy dependency of Madrid households is reflected in the last Autonomous Region of Madrid Energy Report (Fenercom, 2012) which makes the residential sector responsible for the 24% of the energy consumed within it. Besides that, according to data from the project SECH-SPAHOUSEC, the 66% of this energy is used in air conditioning.

6.2. Social consequences

In line with this intensive household energy use, it should be questioned whether some inequalities in consumption can be found among families according to their economic situation.

First results obtained from data gathered in Family Budget Survey showed a 13% of households that spent more than the 10% of their income in energy bills in 2011. Furthermore, for the same year, explored data from the EU-SILC, indicated that 2% of household declared being unable to pay to keep home adequately warm, 6% declared arrears in utility bills within last 12 months and 9% had leaking roof, damp walls or rotten windows in their dwellings.

The exploitation of data from the Household and Environment Survey, according to household income level, showed differences in housing facilities which are strongly related to the presence of fuel poverty. Regarding domestic facilities, the difference between higher and lower income households is almost the 20% for the presence of heating and reaches the 30% when it refers to cooling. Furthermore, the variance in the number of months in which households tend to turn on the heating was set out. Almost the 60% of high class households declared using the heating for three months while only the 35% of lower income families affirmed that.



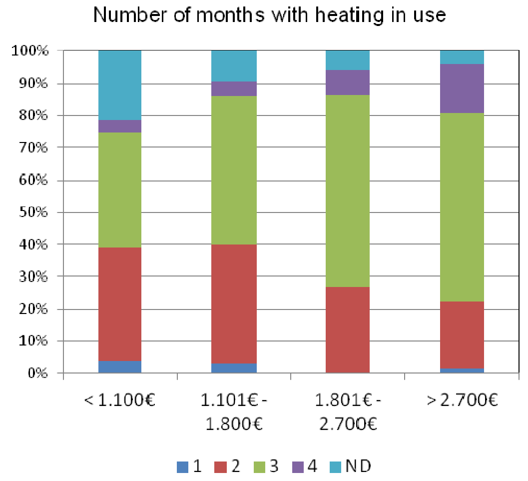


Figure 3. Heating and cooling availability according to household income level (percentage of households) and Figure 4. Number of months with heating in use depending on household income level (percentage of households)

Given these results, it could be argued those households enjoy more efficient houses. For that reason, dwelling enclosure data was explored as well in order to appraise dwellings thermal performance. Results for the existence of blinds, double glazing and windows with thermal break revealed differences among income levels with higher rates among higher incomes. Derived from this first housing analysis it can be stated that low income households are forced to spend more money in energy bills or, in case they cannot afford it, suffer from living in cold and hot houses.

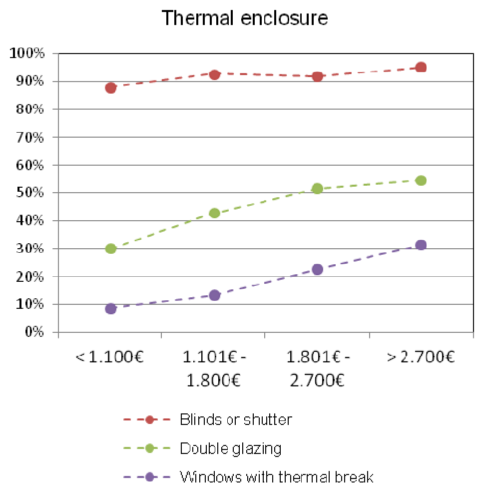
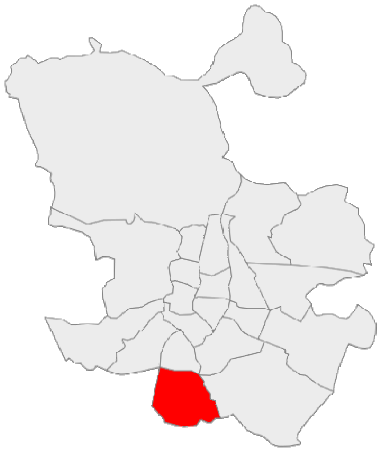


Figure 5. Presence of thermal efficiency measures in dwelling enclosures (household percentage)

Once the inequalities related to shelter were set up among different income groups for the Autonomous Region of Madrid, a neighbourhood was chosen as a case study in order to down the scale of study. The selected neighbourhood, San Cristóbal de Los Ángeles, located in the South of Madrid, is part of the *Vulnerable Neighbourhood Catalogue* (Hernández Aja, 2011). Moreover, in accordance with the method implemented in Part 4.2.2, it is a *workers* neighbourhood and presumably with low income families.

Through the study of data relative to the housing stock from 2001 census, there were stated poor housing conditions among low class society. In line with data obtained from the Household and Environment Survey, the comparison between San Cristobal and Madrid mean values showed a lower heating and cooling availability. To add more, the use of electricity as heating energy source is pointedly higher in the neighbourhood which increase household vulnerability given constant arising of electricity costs. Regarding the quality of the buildings, a higher presence of old buildings was reported. That is a relevant item given that the majority of them were built before the first energy efficiency regulation in Spain, launched in 1979 (CT-79). At last, a higher percentage of buildings in poor conditions were accounted.



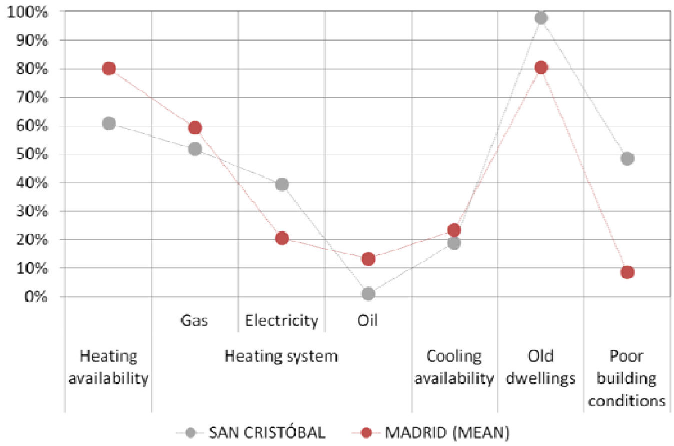


Figure 6. Location of San Cristóbal de los Ángeles within the city of Madrid and Figure 7. Dwelling characteristics comparison between San Cristóbal neighbourhood and Madrid mean values

7. CONCLUSION

In progress

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Desigualdades sociales en salud en la Comunidad de Madrid http://www.madrimasd.org/blogs/salud_publica/category/desigualdades-sociales-en-salud-en-la-comunidad-de-madrid